Emphasis on Regeneration of the Bear Grass (xerophyllum tenax) within the Wolf Timber Sale

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EXECUTIVE SUMMARY

This project analyzes and develops a prescribed burn to reintroduce fire for bear grass regeneration (*Xerophyllum tenax*) located within the Wolf Timber Sale, Plumas National Forest. This project area was chosen for two reasons.

1) To analyze and develop a prescribed cultural resource burn within a traditional Maidu bear grass gathering site. Bear grass leaves are used by traditional weavers to make baskets.
2) To develop a successful working relationship between the U.S. Forest Service and the Maidu Indian tribe in the conservation of federal and Indian lands.

Traditional Maidu gathering sites were naturally subjected to weeds, diseases, and insects. Management was required to keep these competitors in check and enhance the qualities that were culturally valued. Historically the Maidu burned every year, eliminating the underbrush, keeping the forest open, and reducing the likelihood of destructive forest fires. Traditional burning practices for this area occurred until the early 1800s. European settlement in the mid-1800's changed or eliminated historic and cultural land use.

Project Procedure

I used the following tools and techniques to analyze the fuel, weather, plant, and fire behavior conditions at the Wolf Timber Sale.

1) Aids to Determining Fuel Models for Estimating Fire Behavior (technical reference).
2) Daubenmire method for lay out of three permanent 20-meter transects. Quadrant frames allow measurement and recording of leaf lengths. This method is suitable for bear grass and it allows tracking of new growth the following year after burning.
3) Excel Spreadsheet to average leaf length for each plant within all plots.
4) KCFAST to gather 20 years of historical weather from Chester NFDRS station (040904). The values for temperature, relative humidity, 1-hr and 10-hr fuel moistures (FF+ daily listing) were entered into Excel to obtain averages for September-October and July-August
5) Fire Family+ was used to determine the 50^{th}, 90^{th}, and 97^{th} percentile values for September-October and July-August.
6) BEHAVE outputs were analyzed for fire behavior conditions for a summer and/or fall burn.
7) FOFEM was used to assess stand mortality.
8) Scorch Model from BEHAVE was used to analyze for scorch height.

Project Recommendation

The current conditions of the Wolf Timber Sale area require a treatment method to restore and enhance the bear grass. Using fire would replicate the American Indian traditional process, but under a prescribed burn condition. From the study results, I recommend an under-burn to allow for the regeneration of bear grass. Prescribed fire would enhance supple new leaf growth the following year after burning. It is these leaves that are sought after by traditional Maidu basket weavers to make their baskets.

INTRODUCTION

This project will re-introduce fire within the Wolf Creek area (located in the Plumas National Forest, Mt. Hough Ranger District) to mimic the use of fire by American Indians, in a traditional basket gathering site that is still used by Maidu Indians of Northern California. Historically, selected areas were burned exclusively for basket weaving material by the Maidu, which were located within moist, shaded areas. Burning these areas allowed the Maidu to keep the unwanted vegetation from encroaching upon their gathering sites, and reduced the buildup of the fuel load.[1]

Although the Plumas National Forest has an extensive prescribed burning program, there is not a current cultural resource burning program. In 1995, Dave Peters, the Quincy District Ranger met with representatives from the Maidu Cultural Development Group and basket weavers to discuss implementing a cultural resource burning program. After further meetings, a site was selected and it became known as the Wolf Creek project. This site is recognized as a traditional Maidu bear grass gathering area. The Maidu people wanted the USFS to conduct a burn for this particular area so they could gather bear grass as they did in the past.[2]

Bear grass is used by traditional weavers to make their baskets and its primarily used as an overlay on baskets. The color of the leaves varies from white to green and contrasts with the darker material. Burning is the only way to eliminate dead, dry blades from the previous year's growth and encourages supple new blades. The center leaves of the plant are the most sought after by basket weavers. Burning during the fall will regenerate strong, thin, pliable leaves for the next year.[3]

Presently, the project unit is located within the Wolf Timber Sale. This area was logged in 1994 and every 10 years previously.[4] Historical records indicate that there wasn't consistent burning since the 1850's. This was due to the Maidu being removed from the area after gold was discovered nearby and settlers claimed the land.[5]

HISTORY

By 1850, the discovery of gold caused an increase of miners to this particular area. In 1854, California Indians were placed within rancherias by the U.S. Government and could no longer care for their traditional lands. The settlers who moved within Indian Valley (Greenville, CA), used prescribed fire as the Maidu had, but then stopped and allowed the area to become overgrown. The settlers activities concentrated on such things as ranching, farming, and gold mining throughout the area.[6]

The woodland areas were relatively open prior to 1900. This was due to aboriginal burning by Indians and also burning by settlers. When burning was prohibited after 1900, the brush became

[1] Ackerman, M. (Cultural Resources) 1999, personal communications
[2] Ackerman, M. (Cultural Resources) 1999, personal communications
[3] Ortiz, B.R. 1998 Following the Smoke, News from Native California, Volume II, Number 3, Pages 21-29
[4] Churchill, D (Soils) and Clements, D (Silviculture) 1999, personal communications
[5] Flippi, J. 1999 Plumas County Museum, personal communications
[6] Dunn, M.E. 1991 The Maidu Indians of Plumas County, publications 8 and 24

thicker in these areas until after World War II, and then controlled burning was again being used to bring back the open conditions that were known previously.
By 1946, the U.S. Forest Service was using prescribed fire but on less broader areas and were suppressing fire instead of working with it to maintain the park-like effect that was generated by the Indians. Fire was seen as an enemy that totally destroyed everything and had to be put out at all cost (*).

In the first part of the twentieth century, when man-made fire was forbidden and lightning fires were contained, the undergrowth became exceedingly thick so that crown fires increased with devastating effects. California Indians, who were an aboriginal population, had considerable effect on the landscape, almost entirely by means of fire. It is difficult to determine the use of fire in the grassland areas. Several reasons for use of fire were to control growth of brush and promote the growth of seed-producing grasses, and to promote hunting. Evidence indicates that woodland areas were burned annually to control brush, and promote growth of seed-producing plants. The usual time for burning was after the seed harvest and ranged from April to October depending on the crop of particular interest.[7]

Most plants that tribal people value are shade-intolerant and depend on burning or other forms of disturbances. There were times when these disturbances were the result of natural processes such as fires, floods, or windstorms, but they were often deliberately introduced by humans. For thousands of years American Indians recognized that these vegetative habitats would have to be actively managed, rather than merely gathered from, if they were to be maintained. In these cases, as in many other American Indian ecosystems, the principal management tool was fire. The removal of American Indians from their homelands to reservations and rancherias led inevitably to the gradual decline in number, range, and diversity of these and many other habitat types.[8]

For Indian people, fire use was as essential as axes and plows were to the settlers. Many native plant populations need more than protection from grazing, mining, and off-road vehicles; they need fire. The right time and place to set a fire was determined by studying weather conditions and fuel loads. Fall was when the most fires were set when cool temperatures and air moisture would help keep fires from burning too hot. Early explorers, settlers, and miners wrote and described a landscape that had been burned by the Indians. Settler's diaries spoke of open, park-like forests and meadows. Now it is a description that no longer fits. In the mid-1800s, Indian land management was removed and conditions changed drastically afterwards. At the turn of the century, the tradition of setting frequent low-intensity fires were disdained by foresters and total fire suppression became public policy.[9]

Today, by managing forests with fire, the U.S. Forest Service faces many obstacles such as: strict air-quality standards, limited time periods to set safe controlled burns, and property liability concerns. These factors constrain the process of burning, as we have to adhere to air quality standards before we can burn selected areas within the forest.

[7] Lewis, H. 1973 Patterns of Indian burning in California: Ecology and Ethnohistory * denotes same person
[8] Anderson, K and Blackburn, T.C. 1993 Before the Wilderness
[9] Levy, S 1995 Forests Under Fire, Rekindling Embers of Native Stewardship, magazine article, Pages 34-40

Horticultural methods used by basket weavers

The heart of the complex art of Indian basketry lies in horticultural practices. The act of weaving a basket is the culmination of a long process in which the weaver tends and gathers a variety of native plants including deer grass (*Muhlenbergia rigens*), sedge (*Carex sp*.), bracken fern (*Pteridium aquilinum*), sourberry (*Rhus trilobata*), and redbud (*Cercis occidentalis*). The aftermath of fire is where much of the basketry material thrives.[10]

Harvesting: is critical to weavers in managing the resources they gather. Weavers must know the proper time in the plant's life cycle to gather materials. They must first take the view of a botanist because basket weavers must know their materials before they can become proficient at gathering. Gathering implies respectfully taking only what you need and respectfully giving back for what you take. It is only by gathering responsibly that one guarantees the future harvest. Collecting implies hoarding with no attention paid to the method used or quantity taken. Specific gathering times apply to nearly all basketry materials. Gathering occurs in the spring to early fall for a variety of vegetative species after previous fall burning (*).

Fern Stems: used in overlays on baskets. They are gathered in the latter part of August and until the first frost hits the area. If gathered too early, the stems will break from lack of firmness. If gathered too late, they will break from brittleness (*).

Roots: Willow roots are gathered after floods when the soil is washed away and gathering is easier. Digging for willow roots is more time consuming and it takes longer to gather the needed material (*).

Shoots: picked (cut) in early spring before the buds break out and before the leaves are fully matured. Picking then allows the bark to be peeled easily and the shoots are more flexible to weave with (*).

Pruning: willow and redbud benefit from pruning during the springtime. Pruning increases the productivity of the willow and encourages growth of new long, straight, and flexible shoots (*).

Elevation and Altitude: affect gathering times. Growing locations are important. Bear grass is picked from mid-April through July. Bear grass needs a shady location to produce good shoots for baskets. It will become bleached out and brittle if growing in sunny places with no shade [11]

Weather: Basket weavers must pay attention and keep an eye on the locations of gatherable areas as hot weather tends to dry out basket materials before they can be gathered (*).

Cultivation and Debris clearing: by cultivating the roots and rhizomes in the same area every two years and removing accumulated debris, the basket weavers improved the growing conditions (*).

[10] Ortiz, B.R. 1998 Following the Smoke, News from Native California, Volume II Number 3, Pages 21-29
[11] Anderson, K. M. and Blackburn, T.E. 1993 Before the Wilderness * denotes same persons

Controlled Burning: used by California Indians to enhance the growth of certain basketry materials. Burning bear grass resulted in strong, thin, and pliable leaves. Burning returns important nutrients to the soil, eliminates unhealthy plants, reduces pests, and sufficient spacing of vegetation allows for the plants to receive sunlight, water, and nutrients to grow (*).

Private Property: basket weavers have limited access to these materials unless an agreement is made with the landowner. Even then, basket weavers must assure the landowner that no harm is intended and their cultivation methods actually benefit the land (*).

Public Property: access is also limited to gathering basketry material here, because of public land laws and management practices. If a gathering site is lost due to construction purposes, it takes at least a year of attention by basket weavers in pruning and cultivating before a new site will yield useful basketry material.[12]

Commercial Flower Arrangements: bear grass is harvested and used in flower and decoration displays. Traditional weavers are concerned about this because the entire plant is removed and an area can be picked entirely clean of bear grass.

Special Forest Products: culturally important uses of botanicals (e.g. sedges, deer grass, bear grass, redbud, mushrooms, ferns) which are important to many Indian people and other cultural groups (*).

Personal Use of Special Forest Products: described as the amount and type that would be used by an individual or a group for their own use. It often deals with small quantities of materials in a manner that has little to no effect on the resources. If the product is being used for basketry purposes and being sold later, it still would be considered a personal use (*).

Commercial Use: collecting special forest products for sale to an entity for further processing and resale. An example would be collecting mushrooms for sale to a processing market versus using it for personal consumption. Generally, personal use should have preference over commercial use of special forest products unless the appropriate line officer makes a management or project decision giving preference to the commercial concern (*).

Permits for Special Forest Products: sale of special forest products is under the same authority as other timber sales described in the National Forest Management Act (NFMA) and implemented by 36CFR 223.1. Issuing of a permit is discretionary and may consider whether the permit is for commercial or personal use. Unless it is necessary to control use or there are significant removals, gathering for personal use of small amounts of forest products is permissible without a permit or fee.[13]

Herbicide and Pesticide Spraying: public and private lands where basket weavers gather presents special concerns, as weavers use their teeth to split the material with. This causes sickness and health concerns among basket weavers. The U.S. Forest Service uses herbicide spraying as part of restoration projects to eliminate hardwoods and other plant species that grow productively after a wild fire. The intent here is to enhance the growth of new tree seedlings. Forests should

[12] Anderson, K. and Blackburn, T. 1993 Before the Wilderness * denotes same persons

[13] U.S. Forest Service, file code 2460/2600/1563, Pacific Southwest Region directive in regards to California Indian Tribes and Communities * denotes same directive

continue to consult with tribal governments, traditional land users, and others who have an interest here (*).
The U.S. Forest Service is notifying the public about their spraying projects and seeking alternative solutions to their treatment methods. California Department of Transportation (CALTRANS) sprays pesticides along highways to eliminate weeds. They are also working with the public and California Indian tribes in seeking other ways to treat these areas

U.S. Forest Service Burning Policies: fire suppression policies make it difficult for basket weavers to gather their materials. Burns are usually located in inaccessible areas and are hard to find. Some of these burns are not timed right for optimal plant growth. By burning late in the year, it leaves basket weavers with little time to gather a reliable supply of quality materials. The U.S. Forest Service and contemporary weavers are working together to resolve these issues and some progress has been made. The Forest Service has begun to take basket weavers needs into account when conducting prescribed burning.[14]

California Indian Basketweavers Association (CIBA): founded in 1989. Its purpose is to preserve, promote, and perpetuate California Indian basket weaving traditions. CIBA is a sounding board that is communicating and working with government and state agencies, and others to educate them about their ways and how it may affect the basket weavers. CIBA hosts an Annual Basket Weavers Conference that promotes traditional basketry methods. Basket weavers can maintain communications with other weavers to exchange techniques and information about their art.[15]

Gathering Bear Grass

Basket weavers look for and gather from a healthy plant. Color is important as it adds to the imagery of the basket. Weavers harvest only from the center of the plant and leaves are gathered in uniform lengths. Grass that is gathered too far from the center has a purplish color at the ends. This indicates that the grass dries out quickly and becomes too brittle to weave with. Another indicator of good grass leaves is if the edges curl inward as this means it is pliable and good to weave with, and the edges curling outward means that it will become brittle and not workable.[16]

To gather quality bear grass, the weavers look under timbered canopies for the best and longest leaves. Quantity and quality are assessed in selecting bear grass sites. Once gathered, the bear grass is sorted by length. Long leaves are used in large baskets and small leaves for smaller baskets. Leaf blades predict the size of willow root to use and they need to be matched to the size of the root (*).

The willow root is used as the base with bear grass woven in between. Weaving a large size basket takes from 1,000-2,000 leaves. The light coloring of bear grass is obtained by laying it out in the sun to bleach it on one side. Before nightfall, the bear grass must be picked up and taken inside to protect it from the moisture from the air. To bleach the other side it is laid out the next day until the right color is reached.[17]

[14] Anderson, K and Blackburn, T. 1993 Before the Wilderness * denotes same persons
[15] Greenfelder, S. (Director, California Indian Basket weavers Association) 1999 phone conversation
[16] Burdick, S. (Basket weaver)1999 phone interview
[17] McCovey, K. (Cultural Resources) 2000 phone interview (*) denotes same person

Weaving:

Bear grass can be stored in bundles of the same length and they will keep until needed for basket weaving. The weaver keeps a bowl of water nearby during weaving to keep the bear grass pliable. Being careful to not allow the grass to sit in the water for too long because the leaves will turn green again. Bear grass turns to a white color after it dries out and this color contrasts with the rest of the basket's other colors.[18]

Burning:

Bear grass is picked during the summer (July) and, after gathering is complete, the rest of the leaves on the plants are trimmed off. This helps to aid in the fall burning annually because by then it would be dried out and ready to be burned. This will ensure that the weaver would have good leaves to pick the following summer for basket weaving.[19]

In the past, the men used pitch sticks to burn with and larger fuels were removed so that the grass did not take too much heat, as this would damage the grass and it would not grow back for a long time. September through October is the best time to burn bear grass. Burning during December is considered too late, because the grass would not have time to grow back for the next year's gathering.[20]

Basket weavers burned bear grass every year. They look for largest clusters of bear grass to burn and allowed the slow creeping of fire throughout. Do not allow drip torch mixture to get on the plants, because this will leave an odor on the plant. Basket weavers use their teeth to aid in stripping their material. A good site location for bear grass is adjacent to roads, for accessibility purposes, because most basket weavers are elderly people who have a hard time gathering basketry material on steep, uneven ground. It will take two years to produce a good healthy crop of bear grass. Weavers only burned what they needed and these areas ranged from one to three acres in size.[21]

PROBLEM STATEMENT

Historically, the Maidu Indians of Northern California burned within the area of the Wolf Timber Sale to encourage the growth of bear grass. Bear grass continues to be sought after and used for basket weaving materials. Traditionally, the Wolf Timber Sale area would be subject to burning every year by the Maidu in the fall. The new spring growth would be gathered the following summer.

Records indicate that there has not been consistent burning since the 1850s. Today, there are few remaining areas that are treated specifically for the enhancement of bear grass. Traditional practitioners experience considerable difficulty in obtaining sufficient quantity and quality of bear grass to maintain this culturally significant activity.

[18] Summerfield-Cunningham, K. (Basket weaver) 1999 phone interview
[19] Baker, L. (Basket weaver) 1999 personal communications
[20] Burdick, S. (Basket weaver) 1999 phone interview
[21] McCovey, K. (Cultural Resources) 2000 phone interview

GOAL

The goal of this study is to develop treatment alternatives for the Wolf Timber Sale area that would promote new growth of bear grass. Re-introducing prescribed fire in the summer and/or fall season will replicate the traditional practice of applying light intensity fire in this area. Prescribed fire will result in eliminating dead, dry leaves from the previous year's growth and will encourage supple new leaves. Traditional practitioners will have a greatly improved source of basket making materials.

OBJECTIVES

1. Develop fire behavior prescriptions (i.e. temperature, relative humidity, 1-hour and 10-hour fuel moistures) for a summer/fall burn.
2. Use Fire Family+ and BEHAVE programs to predict results for a summer/fall burn.
3. Use FOFEM and Scorch Model to analyze mortality and scorch height for the project site.
4. Select method(s) to measure amount and length of bear grass leaves for the project area.
5. Use method to plot current bear grass and to record new growth the following year.
6. Develop two year monitoring plan for future measurement of success.

PHYSICAL DESCRIPTION

Topography:

The Wolf Timber Sale, is located two miles southeast from the town of Canyon Dam. One mile to the north of Canyon Dam is Lake Almanor; this lake is 15 miles long by 8 miles wide. The project area covers 7 acres with a 10 percent slope and is adjacent to the Calgone Mine. The Lassen National Forest is on the north side of Hwy 89. The Lake Almanor area receives heavy recreational use during the summer due to the numerous campgrounds, hiking trails, fishing, and boating activities. Winter activities include ice fishing, snowmobiling, and cross-country skiing.

Aspect:

The traditional Maidu bear grass site is situated on a north aspect with canopy shading of 70 percent throughout the unit. Slope varies from 10 percent at the bottom to 40 percent at the ridge top. The north aspect generally holds more moisture and dries out later in the season; the snow melt is longer, moisture content of larger fuels dry slower, and day-time temperatures are a little cooler during the fall season.

Discussions with basket weavers about the north aspect revealed that the weavers were able to gather elsewhere first. They came to the cooler places, such as the one near Canyon Dam to continue their gathering later in the season.[22]

The basket weavers knew where to gather first by checking known burned areas and gathering what the area had to offer, and then moving on to other areas. By checking these areas, the

[22] Baker, L. (Basket weaver) 1999 personal communications

basket weavers looked at the color and the health of the plants prior to gathering. Gathering time was in May through July and generally ended up on the north side of the mountain where it was cooler, and there was more shade.[23]

The north aspect was moister and the Maidu selected, burned, and gathered basketry material on this side because the sun did not get hot enough to dry the bear grass out and large amounts of shade were good for the growth. Generally, the Maidu gathered their material from several places because one area may not offer enough basketry material needed to construct a basket.[24]

The south aspect comes into green-up sooner and if the bear grass was not under a shaded canopy it dried out faster and became brittle which was no good to weave with because it breaks easily. Fires that were set on south aspects were timed so they generally did not become intense large fires.[25]

Project Area Description:

The current vegetative community consists of a mixed conifer forest of Douglas-fir (*Pseudotsuga taxifolia*), incense cedar (*Libocedrus decurrens*), and white fir (*Abies concolor*). Manzanita (*Arctostaphylos sp*.), dogwood (*Cornus nuttallii*), and white thorn (*Ceanothus cordulatus*) are scattered within the unit. Bear grass occupies three quarters of the unit on the ground. Tree height is between 20 and 70-ft. and tree diameter is between 10 to 24 inches and sapling regeneration within the site. Although the project is seven acres in size, only one acre will be under burned at this time. Aspect is north, slope is 10 percent and located at the base of a mountain. Logging was completed in 1994, 1984, and 1974 throughout the Wolf Creek area.

METHODOLOGY

Weather:

The weather station (National Fire Danger Rating System, NFDRS #040904) at Chester, California, on the Lassen National Forest, Almanor Ranger District was utilized for this project. The Chester weather station is located 14-miles north of the project site and has 20 years of historical data. It is the only NFDRS station for the area.

The historic weather data were retrieved from the Kansas City Fire Access Software program (KCFAST).[26] This weather data was entered into Fire Family+ and used the 50th, 90th, and 97th percentiles to predict average worst-case weather values to define fire behavior. For the Fire Family+ analysis, Burning Index (BI) was used as the season variable, which uses wind, slope, live fuel moisture, and fuel model as parameters and BI is linearly related to the length of flames at the head of the fire.

The Western Regional Climate Center (WRCC) based in Reno, NV have a weather station at Canyon Dam (041497) located two miles north of the project area.[27] This station has been

[23] Burdick S. (Basket weaver) 1999 phone interview
[24] Summerfield-Cunningham, B. (National Park Service) 1999 phone interview
[25] Burdick, S. (Basket weaver) 1999 phone interview
[26] http://famweb.usda.gov/ web address for KCFAST
[27] www.wrcc.dri.edu web address for WRCC

located there since 1948. Nineteen years of historical weather (1980-1999) were used for consistency due to data gaps between 1960 to 1978. Although this station is not an NFDRS station, it was used for temperature comparisons to the Chester station.

The Canyon Dam weather station has an average temperature of 70-degrees. The average temperature for July and August is 83-degrees.[28] These temperatures can be compared with the Fire Family+ outputs to verify a consistent temperature for September-October and July-August (see Appendix 4-C).

Fire Family+ (version 1.2, 9/1999):

The Fire Family+ (FF+) tool allows fire managers to retrieve weather and fire data to make decisions concerning fire probabilities. FF+ was used to import and analyze twenty years of historical weather.

Next, the daily listing in Fire Family+ was used to obtain averages for the following: (1) temperature, (2) relative humidity, (3) 1-hour fuel moisture, and (4) 10-hour fuel moisture. September-October and July-August were chosen as the months to conduct a prescribed burn. With the results from the daily listing run I entered these figures into an Excel spreadsheet and came up with the averages below (see Appendix 4 and 4-A).

September 1st to October 31st, 1979-1999

Temp	RH	1 HR FM	10 HR FM
71.3	31.2	6.2	10.2

July 1st to August 31st , 1979-1999

Temp	RH	1HR FM	10 HR FM
83.1	23	4.4	7.2

Figure 1. Averages between September-October and July-August.

The temperature averages from the weather station in Reno and Fire Family+ show a 1-degree temperature difference for September-October (see Appendix 4 and 4C). The 1-hr and 10-hr fuel moistures are lower for Burning Index (see Appendix 3 and 3-A). The 1-hr and 10-hr fuel moistures are slightly higher for the daily listing runs (see Appendix 4 and 4-A). By using these methods I was able to find the consistent values for temperature, relative humidity, 1-hr and 10-hr fuel moistures. With these known averages, a fire behavior prescription was developed. The next step was to use the Behave program to produce actual fire behavior prescriptions for the selected months.

Fuel Modeling:

To accurately predict fire characteristics with the Behave program, a fuel model must be determined and used as input to simulate a forward moving fire. There are 13 fuel models that are described by surface area to volume ratio for each size class, fuel load, fuel bed depth, and fuel moisture.[29]

Bear grass covers 75 percent of the project area. Down woody debris consists of rotten logs scattered within the project area. The primary carrier of fire for a Fuel Model 2 (timber with grass under story) is the fine fuel (1-hr). Fire spread is primarily through the fine herbaceous

[28] Ashby, J. (Meteorologist) 2000 phone conservation
[29] Anderson, Hal E. 1982 Aids to Determining Fuel Models for Estimating Fire Behavior, GTR-INT-122

fuels, either curing or dead. The herbaceous material, litter, and dead down stem wood from the timber over story also contribute to the fire intensity. The following values describe Fuel Model 2. Values from the "Aids to Determining Fire Behavior" guide were used as a reference for the dead and live fuel loads. These values are similar to the fuel loads within the project site.[30]

Fuel model values for estimating fire behavior

Total fuel load,<3 Dead/Live tons/acre	4.0
Dead fuel load,1/4 inch, tons/acre	2.0
Live fuel load, foliage, tons/acre	0.5
Fuel bed depth, feet	1.0

Figure 2 Fuel Model 2 Values.

To estimate the amount of bear grass plants for the unit, four 10-ft by 10-ft. plots were used. These plots were laid out within the 75 percent representative bear grass area. 141 plants were located in four plots. The total number of plants for one acre was computed by 141÷400 sq.ft. = .35 (plants per sq.ft.) x 43,560 (sq.ft. in acre) = 15,246 plants for this area.

Behave:

The Behave program (Remsoft, 97.0) was used to input the weather results for September 1st to October 31st and for July 1st to August 31st. This output data, from the Moderate, High, and Extreme values helped decide what the actual fuel moisture values were for 1-and 10-hour fuels. A low intensity fire and flame length was desired that would consume the bear grass and keep tree scorch damage minimal.

Low intensity fire was desired, since it (less than 200-degrees F), can increase soil fertility by releasing nutrients that enable the plants to grow more vigorously the following year after being burned. if fire intensity reaches a sustained temperature (above 400-degrees F) it volatilizes organic matter, is lethal to fungi and bacteria, and creates hydrophobic soil conditions.[31]

I selected a Fireline Intensity (FLI) of one hundred btu's/ft/s because I wanted to stay under two hundred btu's since this is the desired condition for soil fertility to promote the vigorous growth of bear grass. I chose to keep the Flame Length (FL) near 2.5 ft. because the plants located within the project site measure 1.5 ft. high. Thus, the flame length would be high enough to consume the bear grass plants. For the area in question, I wanted either a head and/or backing fire. I used the Behave program to see which method was more feasible.

The fuel moisture inputs (as determined by FF+) were used in the Behave program for analysis at the 50th, 90th, and 97th percentile levels. (September 1 to October 31, 1979-1999 see Appendix 3). Interest was only in the 1-and 10-hour fuels because the project area is pre-dominantly 1-hour fuel. The mid-flame wind speed was calculated from the 20-ft. winds by multiplying a wind adjustment factor of 0.2, which is (partially sheltered fuels).[32]

[30] Rudolph, D.(Fuels Specialist) 1999 personal communications
[31] Churchill, D. (Soils) 2000, personal communications
[32] 1992 Fire Behavior Field Reference Guide, Wind Adjustment Table

Figure 3 Burning Index input values (Behave program).

COMPONENT RANGE	50th	90th	97th
1 HR Fuel Moisture	5.0	3.9	2.9
10 HR Fuel Moisture	8.3	6.0	4.8
100 HR Fuel Moisture	11.8	8.1	7.0
Herb Fuel Moisture	57.5	38.1	48.4
20 FT. Wind Speed	5.5	9.9	12.5
Mid-Flame Wind Speed	1.1	2.0	2.5

Table 1 Behave outputs for the 50th percentile level (Sept.-Oct.).

Head Fire	Backing Fire
Flame Length, ft----------2.7	Flame Length, ft----------1.4
Fireline Intensity, btu/ft/s-----51	Fireline Intensity, btu/ft/s------11
Rate of Spread, ch/hr----------5.6	Rate of Spread, ch/hr----------1.3

Table 2 Behave outputs for the 90th percentile level (Sept.-Oct.).

Head Fire	Backing Fire
Flame Length, ft----------4.1	Flame Length, ft----------1.7
Fireline Intensity, btu/ft/s-----123	Fireline Intensity, btu/ft/s------17
Rate of Spread, ch/hr----------12.7	Rate of Spread, ch/hr----------1.8

Table 3 Behave outputs for the 97th percentile level (Sept.-Oct.).

Head Fire	Backing Fire
Flame Length, ft----------3.5	Flame Length, ft----------1.9
Fireline Intensity, btu/ft/s------199	Fireline Intensity, btu/ft/s------23
Rate of Spread, ch/hr----------19.2	Rate of Spread, ch/hr----------2.2

Behave program predicts that a prescribed burn can be conducted at the 50th percentile level for a backing fire since the desired flame length does not exceed 2.5 ft. Head fires at the 50th, 90th, and 97th percentile levels exceed the 2.5 ft. flame length outside of the desired prediction. At the same 90th and 97th percentile levels the flame length is within the desired range for a backing fire. The Behave runs predict that a fire behavior prescription for the fall season is best (see Appendix 3).

The same procedures above were performed with the Behave program to obtain results for July 1 to August 31, 1979-1999 (see Appendix 3-A).

Figure 4 Burning Index input values (Behave program).

COMPONENT RANGE	50th	90th	97th
1 HR Fuel Moisture	4.1	3.2	2.3
10 HR Fuel Moisture	6.6	5.7	3.8
100 HR Fuel Moisture	9.5	7.2	5.6
Herb Fuel Moisture	57.5	38.8	33.5
20 FT Wind Speed	7.5	10.1	12.3
Mid-Flame Wind Speed	1.5	2.0	2.5

Table 4 Behave Outputs for the 50th percentile level (July-August).

Head Fire	**Backing Fire**
Flame Length, ft----------3.4	Flame Length, ft----------1.5
Fireline Intensity, btu/ft/s------80	Fireline Intensity, btu/ft/s------14
Rate of Spread, ch/hr----------8.4	Rate of Spread, ch/hr----------1.5

Table 5 Behave outputs for the 90th percentile level (July-August).

Head Fire	**Backing Fire**
Flame Length, ft----------4.3	Flame Length, ft----------1.8
Fireline Intensity, btu/ft/s------138	Fireline Intensity, btu/ft/s------19
Rate of Spread, ch/hr----------13.6	Rate of Spread, ch/hr----------1.9

Table 6 Behave outputs for the 97th percentile level (July-August).

Head Fire	**Backing Fire**
Flame Length, ft----------5.4	Flame Length, ft----------2.0
Fireline Intensity, btu/ft/s------221	Fireline Intensity, btu/ft/s------26
Rate of Spread, ch/hr----------20.3	Rate of Spread, ch/hr----------2.4

Behave program predicts that at the 50th Percentile level the flame length for a head fire exceeds the 2.5 ft. limit, but a backing fire does not. At the 90th and 97th percentile levels for a head fire the 2.5 ft. flame length is exceeded. At the same 90th and 97th percentile levels, the desired range is acceptable for a backing fire. The Behave program predicts a fire behavior prescription for the summer season (see Appendix 3-A).

Reasoning:

Fire Family+ and the Behave programs were used to develop fire prescription parameters for the project area.

It is highly unlikely that a prescribed burn would be allowed during the summer due to the fire suppression policy on the Plumas National Forest.[33] Other factors that limit summer burning were possible escaped fire and loss of basketry material before basket weavers could gather it. It is because of this policy and these factors that I chose not to go any further with July and/or August as the possible months to conduct a prescribed burn. I did include the below values after using the Behave, Scorch Model to show the results for low fuel moisture values (90th and 97th) predicted by Behave program shows unacceptable high scorch heights for the project area.

Scorch outputs for July 1st to August 31st, 1979-1999
Ambient Air Temperature = 83 degrees
Figure 5 scorch height and flame length levels.

Head Fire	**Backing Fire**
Crown Scorch Heights/Flame Lengths	Crown Scorch Heights/Flame Lengths
50th Percentile Level = 21 Feet/3.4	50th Percentile Level = 6 Feet/1.5
90th Percentile Level = 20 Feet/4.3	90th Percentile Level = 8 Feet/1.8
97th Percentile Level = 41 Feet/5.4	97th Percentile Level = 10 Feet/2.0

[33] Craggs, L. (Mt. Hough R.D. ADFMO) 1/2000, personal communications

FOFEM:

I was interested in stand mortality to verify the effects for either a head and/or backing fire. The First Order Fire Effects Model (FOFEM) was used to predict scorch height. The following results were obtained and evaluated for tree mortality.

Figure 6. Stand tree mortality.
Average mortality by species/diameter entry (see Appendix 5).

		Flame Lengths			
Species	DBH	2’	4’	6’	8’
Doug-fir	10	.3	.3	.9	1.0

Tree Mortality Indexes:
Average probability of mortality: .25
Number of trees killed by the fire: 25
Average tree diameter (DBH) killed by fire (inch): 10.0
Average probability of mortality for trees 4+ in. DBH: .25
Total pre-fire number of trees: 100

Figure 7. FOFEM mortality values for 50th percentile level.
PREDICTED PROBABILITY OF MORTALITY
Scorch height = 5ft. at 50th percentile (backing fire).

Doug-fir	Diameter classes (2 inch)												
2	4	6	8	10	12	14	16	18	20	22	24	26	28
.79	.62	.48	.35	.25	.19	.14	.11	.08	.07	.05	.05	.04	.00

Scorch height = 12ft. at 50th percentile (head fire).

Doug-fir	Diameter classes (2 inch)												
2	4	6	8	10	12	14	16	18	20	22	24	26	28
1.00	.66	.48	.35	.25	.19	.14	.11	.08	.07	.05	.05	.04	.00

Reasoning:

FOFEM allows the user to select either the tree and/or stand inputs and then flame or scorch to receive predicted mortality data. In using FOFEM I tried more tree and stand selections after the first run (Figure 6). For the tree runs I selected several inputs for live crown heights and came out with higher tree mortalities. The stand selection only gave me the same answer over again (see Appendix 5-1 and 5-2). The diameter class (Figure 7) indicates that the 10” (DBH) level is the same for trees killed at either a head and/or backing fire at the 50th percentile level (see Appendix 5-3).

The conclusions that I evaluated for the above figures indicated that for a 2-ft. flame length (FL) to kill 25 trees at 10” (DBH) seemed unrealistic for the project area (see Appendix 5-2). In FOFEM, I used the flame and scorch parameters to evaluate the results and concluded neither of them made sense for a Fuel Model 2. I decided to use the Behave, Scorch Model to compare the results with the FOFEM scorch run.

The difference with the Scorch Model in Behave is it allowed me to enter a temperature value. The following figure below represent the ambient air temperatures that I used in the Scorch Model (see Appendix 4 and 4-A).

Figure 8 scorch height and flame length levels.
Scorch Inputs for September 1st to October 31st, 1979-1999
Ambient Air Temperature = 70 degrees

Head Fire	**Backing Fire**
Crown Scorch Heights/Flame Lengths	Crown Scorch Heights/Flame Lengths
50th Percentile Level = 12 Feet/2.7	50th Percentile Level = 5 Feet/1.4
90th Percentile Level = 21 Feet/4.1	90th Percentile Level = 6 Feet/1.7
97th Percentile Lever = 30 Feet/3.5	97th Percentile Level = 7 Feet/1.9

The above 50th Percentile results for a backing fire are more realistic with a 2.5-ft. flame length (see Appendix 3). The other values still seem unrealistic for a Fuel Model 2. An actual temperature was used, whereas FOFEM does not use one. I also had the output values from Behave to verify these results (see Appendix 3 and 3-A).

Reasoning:

The Scorch portion in FOFEM and Scorch Model in Behave were both used to analyze scorch heights. The values from both programs varied greatly. The results at the 50th Percentile level indicate the possibility of achieving minimal damage to the timber stand. The loss of timber at the 10" (DBH) level is not really expected because a Fuel Model 2 has a grass under story although there will be scorch marks at 5ft. visible after burning.

The loss of smaller trees (see Figure 6) for the project area can be expected because the flame length would reach them fairly easy as the fire moves through the project area. At the 50th percentile level it would allow minimal damage to the timber stand and low scorch heights because a backing fire would be utilized for the project area in the fall. For the 90th and 97th percentile levels I assume that the lower fuel moistures would allow increased scorch heights to the timber stand.

Method Selection:

For this project, I consulted with Jerry Hustafa (Mt. Hough Ranger District Biologist) and Stacy Scott (Beckwourth Ranger District Biologist). We chose the Daubenmire method and used the linear technique to lay out three permanent points for each plot.[34] This method was modified to fit our needs and not every aspect of the Daubenmire technique was utilized with this project.

Advantages:

1. This method is easy to use and offers a fairly easy way of assessing vegetative changes based on percent (%) cover.

[34] Sampling Vegetative Attributes, 1996 Interagency Technical Reference Cooperative Extension Service USDA-Forest Service, USDI- Bureau of Land Management. Revised in 1997 and 1999

Limitations:

2. There can be large changes in canopy cover of herbaceous species between years because of climatic conditions.

We measured out three 20-meter lines to obtain a quadrate/plot every other meter in order to get enough samples . A coin was flipped to determine start at either 0 or 1 for each plot. 0 indicates meter intervals of 2, 4, 6, 8, 10….etc. 1 indicates meter intervals of 1, 3, 5, 7 and 9 meters.

These three transects were used because the unit did not have enough bear grass to do a long transect on account of patchiness and snow interferences within the unit. Each transect point has been permanently marked at beginning, middle, and end of each line. All quadrates were photographed to mark permanent positions along the three 20-meter interval transects.

The quadrate frame was (see Figure 9) two times larger (1/2 meter x 1 meter) than normal (20 cm x 50 cm) size because the pilot study indicates a larger quadrate is better suited to bear grass as a species. Size, shape, and distribution of the plant fit the larger size frame.

The longest bear grass leaves were measured at the center of each plant, the total number of plants were counted, and plotted within each quadrate for all three transects. The bear grass was mapped out on each plot to show where current individual plants were. This would allow us to identify any new plants and/or movement within each quadrate frame (see Appendix 2-6, Transect #1).

The quadrate frame is used to estimate the canopy coverage of each plant species and record the data by quadrate, by species, and by cover class on the Daubenmire form (see Appendix 2-6, Transect #1). The examiner observes the quadrate frame from directly above and estimates the cover class for all individuals of a plant species in the quadrant as a unit.

Canopies that extended over the quadrate frame were estimated even if they were not rooted in the quadrant. The data must be collected at the time of maximum growth of the key species. Overlapping canopy cover was included in the cover estimates by species, therefore, total cover may exceed 100 percent (absolute measure of cover).

Total ground cover may not reflect actual ground cover. This allows us to look for a change in leaf length after fire as one way to assess a benefit to the Maidu basket weavers. Primary focus is on bear grass, not necessarily the stand composition as a whole.

The following figure below depicts the quadrate frame used to measure and record bear grass plants. A total of 31 quadrates were recorded for all three 20-meter linear measurements. To measure growth a year later, the quadrates can be laid out in the same position to measure the leaf lengths of bear grass and to measure any new growth in the quadrate.

The (*) identifies individual plants within a quadrant frame. Frame scale is ½ meter by 1 meter.

Figure 9 Daubenmire frame was placed at 0 or 1 meter intervals and the bear grass plants were measured, recorded, and plotted within each quadrate. A cover class was assigned for each plot. Other vegetative species were noted and recorded but not plotted because the main species of bear grass was the focus (see Appendix 2-6, Transect #1).

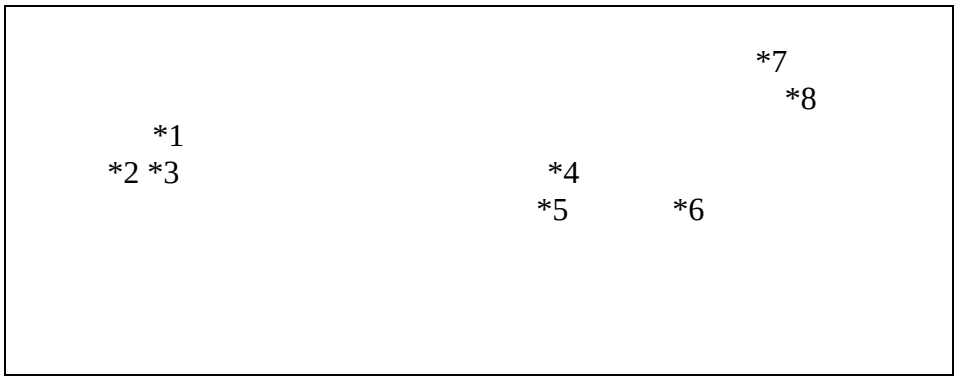

Figure 10 Transect plot sheet. Each row consists of individual measurements (cm) taken at the center of each plant. All the plants measured were within the Daubenmire frame (see Figure 9).

Wolf Timber Sale: Transect #1

Plot 1	Plot 2	Plot 3	Plot 4	Plot 5	Plot 6	Plot 7	Plot 8	Plot 9	Plot 10
16	0	60	65	54	58	34	20	20	0
11		60	57	71	46	30	18	19	
6		59	61	56	54	27	31	35	
26		58	59	67	68	36	24	32	
			54	57	29	24	23	16	
			60	62	63	35	32	26	
			57	62	62	22	17	32	
			60		48	26			
			60		58	36			
			56		59	40			
			37		67	43			
			50		66	39			
						25			
						27			
						27			
						28			

Mean Averages

14.75	0	59.25	56.33	61.28	56.5	31.18	23.57	25.71	0

The above data was entered into an Excel Spreadsheet program to find the average bear grass leaf length of each plot (see Appendix 2-1, Transect #1). Leaf measurements were recorded in centimeters (cm). There are two other transects and they are Appendix 2A-1, Transect #2, and 2B-1, Transect #3.

Vegetative Cover Classes

Cover Class	Range of Coverage	Mid-Point of Range
1	**0 to 5%**	**2.5%**
2	**5 to 25%**	**15.0%**
3	**25 to 50%**	**37.5%**
4	**50 to 75%**	**62.5%**
5	**75 to 95%**	**85.0%**
6	**95 to 100%**	**97.5%**

Figure 11. Cover Classes: Above table is the method that the examiner, observes the quadrant frame from directly above and estimates the cover class for all individuals of a plant species in the quadrant. This data is recorded on a Daubenmire form by quadrant, species, and cover class (see Appendix 2-5, transect #1).

Reasoning:

The transect plot sheet(s) records the individual measurements for each plant. These same numbers can be compared with the new growth measurements to verify any changes in leaf lengths. The three transects and all plots are permanently marked and photographed. This would allow for easier recognition and placement of the quadrate frame for monitoring purposes.

ALTERNATIVE TREATMENT METHODS

There are two alternative methods that are considered for the regeneration of the bear grass.

- No treatment.
- Under-burn unit.

Alternative A

The alternative considered here was "no treatment" for the project area. This would lead to the further decline of the bear grass and would not produce the high quality that is needed by the Maidu Indians to make their baskets.

Alternative B

The type of treatment considered here would be to "under-burn" the project site. By, burning it would remove all surface fuels and regenerate new growth the following year after burning. This may actually mimic the American Indian use of fire, but under a prescribed condition.

EVALUATION OF ALTERNATIVES

Alternative A

No treatment: if this option were chosen, it would not meet the needs of traditional basket weavers to gather weaving material within this area because the vigor and quality need to be restored. This area is still recognized as a traditional Maidu gathering site.

Alternative B

Under-burning: would be preferable because it would remove all the ground fuel within the project site. Historically, the Maidu Indians burned this area every year to encourage new growth for their basketry material needs. This area has not been burned since the mid-1800s. They burned during the fall because of the cooler temperatures and air moisture that helped to keep the fire from burning to hot. By re-introducing fire within this area, the bear grass should produce strong, thin, and pliable leaves for basket weaving purposes.

ECONOMIC COST ANALYSIS

Alternative A

No Treatment = $0

Alternative B

Under Burn
Engine Module personnel cost per/day = $600.00
Mileage = Engine cost @ $.99 per mile @ 30 miles = $29.70
Support Vehicle @ $.18 per mile @ 35 miles = $6.30
Under Burn = $90.00 per acre (dollars collected from Wolf Timber sale)
Mop-up, (day after) = 1 GS-8 AND 1 GS-4 = 1 day with wet unit = $262.00 $.24 per mile @ 30 miles = $7.20 = $269.20
Total = $905.20

Figure 12. Cost analysis for alternatives.

Treatment Method	Total Cost
NO TREATMENT	$0
UNDER BURN	$905.20

Actual cost for the Engine Module per day in Fiscal Year 1999 was $581.00. For fiscal year 2000, I assumed and estimated the new cost to be $600.00 because of the increase of the cost to the government. The average cost for Mt. Hough District under-burning is $90.00 per acre.[35]

Economic benefit:

Basket weavers place no monetary value on the materials themselves, but do place a monetary value on the finished product, a basket. The basket that is produced ranges from a dollar value per inch to a dollar value per item. For example a plate done by a very good weaver may go for $100 per inch while a small "trash" basket may go for as few as ten dollars. No monetary value is placed on the raw materials as they have relatively little value in an unworked state. After the materials are worked their value increases due to the time invested in the harvest and preparation processes. The ultimate economic value is placed on the finished basket.[36]

[35] Swartzlander, K. (Mt. Hough R.D. Fuels Specialist) 1/2000, personal communications
[36] Summerfield-Cunningham, B. 1993 The Conflict Resolution Process Bear grass, Ethnographic uses of Forest Resources.

PRESCRIBED BURN PLAN

At this time a burn plan has been developed for the Wolf Timber Sale area and is scheduled to be completed this year. Preferably, this burn plan will utilize the values for a September and/or October prescribed burn. The parameters for the temperature, relative humidity, 1-hr, and 10-hr fuel moistures have been identified for the fall season. The following information helped to develop a burn plan for the project area.

Background on Cultural Burning:

The following information was acquired by speaking with Stan Pfister, Fuels Management Specialist, Six Rivers National Forest.[37] I was interested in any problems they encountered while implementing their cultural burning program and if there are any continuing problems today.

For the past 10 years, the Six Rivers and Klamath National Forests have worked closely with traditional Indian basket weavers in burning to sustain basketry materials. Most other forests in California have some sort of cultural resource program established and are continuing to develop and maintain working relationships with California Indian Tribes.[38]

The following problems were encountered by the Klamath and Six Rivers National Forests: A.) Smoke management and timing of burns; B.) Small units produced large amounts of smoke; C.) Spot burning of individual plants with drip torch fuel or propane torches during wet periods (November and December) did not produce desired results the following summer; D.) Allowing drip torch fuel in the center of the plants this left an odor that was noticed on the new leaves by basket weavers; E.) Accessibility to the sites complicated the gathering process because most weavers are elderly; F.) Pile placement and large slash piles held heat for longer periods of time killing the bear grass roots; G.) Flames created by large slash piles burned individual and/or groups of trees.

By working with local basket weavers, fuels management for the Six Rivers National Forest developed a fire behavior prescription (see Figure 13) that enabled them to burn the traditional materials that are used in basket making. The Klamath National Forest experienced similar problems and by collaborating with the Six Rivers, the Klamath avoided the same problems. Today, these two forests are continuing their working relationships to enhance prescribed burning projects in providing cultural resource material for Northern California Indian tribes.

Considering the above information, it can be seen that accessibility and shading are two important factors for a gathering site. The Wolf Timber Sale project site is located on the north side of Forest Service road 27N80 and located within a fully sheltered area. Thus, it meets the criteria for selecting this area for treatment. Also it is located in a traditional Maidu bear grass gathering area.

The below fire behavior prescription values were developed and utilized on the Six Rivers National Forest.[39] This prescription was developed in regards to burning bear grass for gathering

[37] 1999 phone interview
[38] USDA Working together California Indians and the Forest Service, 1993-1998 Accomplishment Reports
[39] Hunter, J.E. 1988 Prescribed Burning for Cultural Resources

purposes by the Yurok and Karouk Indian tribes. A highly specific fire behavior is not required to obtain good results and these figures can be used for different areas. According to Stan Pfister, fireline intensity and flame length are important when burning bear grass because you want to have a low flame length (<3 ft.) and a low intensity burn that would produce the desired results the following year after burning.

Figure 13 Example fire behavior prescription.

Fire Behavior Prescription	**Maximum**	**Minimum**
Dry Bulb (temp.)	85	40
Relative Humidity (%)	25	70
1-hr fuel moisture (%)	6	11
10-hr fuel moisture (%)	8	17
Mid-flame Wind Speed (mph)	10	0
Live fuel moisture (%)	75	150

The above fire behavior prescription contains values that allow for cultural resource burning to achieve the desired basketry material results. For the project area, I was interested in the temperature, relative humidity, 1-hr, and 10-hr fuel moistures. Wind was not a factor on account of the project being located within a partially sheltered area and located at the base of a slope. A list of questions was made to guide the development of the Wolf Timber Sale burn plan.

Questions

1) Find out if 85-degree weather is usual for a north aspect in the summer.
2) Determine the average temperature range for the area during the summer/fall.
3) Gather weather data and utilize Fire Family+ program to obtain expected results for the summer and fall months.
4) Use Behave program to process weather values and analyze results.
5) Use these to select the best month(s) to conduct a control burn.

Answering these questions and using Fire Family+ and the Behave program to obtain fire behavior predictions the fall season was chosen to conduct a prescribed burn for the Wolf Timber Sale project area.

CONCLUSION

To regenerate the bear grass within the Wolf Timber Sale area a fuels treatment strategy is needed to enhance the vigor and quality of bear grass. Presently, the condition of the bear grass is unhealthy due to the lack of fire. Historically, the Maidu Indians burned within the area of the Wolf Timber Sale specifically to encourage the growth of bear grass. The new spring growth would be gathered the following summer. Records indicate that there has not been consistent burning in this area since the mid-1800's.

Today, there are few remaining areas that are treated specifically for the enhancement of bear grass. By reintroducing prescribed fire in the summer and/or fall season it will replicate the traditional practice of applying light intensity fire in this are. Prescribed fire will result in eliminating dead, dry leaves from the previous year's growth and will encourage supple new leaves.

To achieve the desired results, a fireline intensity of less than or equal to 100 btu/ft/s and a two and a half-foot flame length is needed to consume all the bear grass within the Wolf Timber Sale. The fuels treatment method of under-burning would enhance the quality of bear grass according to this analysis.

RECOMMENDATIONS

This analysis has outlined two alternatives for consideration. Alternative A would offer nothing in the way of basket material due to no beneficial fire effects on bear grass. Alternative B would produce the desired results of burning bear grass. By reintroducing fire back into the area for bear grass regeneration, the basket weavers will have a traditional area to gather from because the vigor and quality would be restored.

The implementation of this project will create and establish a prescribed burning program for cultural resource purposes. The Plumas National Forest will work with the Maidu Cultural Development Group, basket weavers, and others in maintaining and developing working relationships with Northern California Indian Tribes. By officially recognizing Indian tribes on a formal government-to-government basis and streamlining the process for Indians to gather traditional resources and by actively promoting indigenous management strategies, and protecting traditional gathering areas. National Forests across the United States are enriching the concept of multi-culturalism in land management.

MONITORING PLAN

The Daubenmire method will be used to monitor the regeneration progress of bear grass. This method would allow the users to examine leaf length and assess if new bear grass plant growth occurred the following year after burning. All new growth can be measured and compared to the previous recorded results from the first measurement period.

Changes in leaf length will be noted and recorded. To look for new growth, the quadrate frame can be placed back within the same permanently marked position and the user would be able to detect any new changes of the species by consulting the previous cover class recordings.

The user also can view the before photos to further assess new growth. The paired t-test can be used to test for changes between two years. The traditional basket weavers would be consulted to view the bear grass plants within the project area before and after burning to ascertain if the desired quality needed to weave baskets has been achieved.

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